Partnership for Modeling the Marine Environment of Puget Sound, Washington

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LONG-TERM GOALS

Estuaries, fjords and sounds are important, major components of marine ecosystems worldwide. Because of this, and their generally poor treatment by man, large estuaries should be the focus of large-scale, multidisciplinary, integrative modeling efforts. We need to both understand how these systems work, and be able to predict how they will respond to changes, whether natural or anthropogenic. Puget Sound, Washington State's largest inland sea, is both the largest fjord in the lower forty-eight states and closest to the substantial urban centers of Seattle, Tacoma, Everett and surrounding communities. Relative to other coastal systems, Pacific Northwest fjords have seasonally high annual phytoplankton standing stock and primary production, and they support several economically valuable fisheries. Our long-term goals are to develop quantitative understanding of the seasonal and longer time-scale variabilities of the Sound's circulation, roles of water column stratification, nutrients, and light (and their interactions) on phytoplankton and zooplankton dynamics, and the sensitivity of the physical and the biological system to natural and human perturbations. We will develop models of Puget Sound that can aid agencies with responsibilities for environmental management in making informed decisions and serve as marine science education tools.

OBJECTIVES

The Partnership for Modeling the Marine Environment of Puget Sound consists of five separate organizations: University of Washington (School of Oceanography and College of Education), King County Department of Natural Resources, Washington State Department of Ecology, Puget Sound Naval Shipyard, and Ocean Inquiry Project. The partnership will develop, maintain and operate a system of flexibly linked simulation models of Puget Sound's circulation and ecosystem, a data management system for archiving and exchanging oceanographic data and model results that are accessible to all members of the partnership as well as to the regional and oceanographic community,

and an effective delivery interface for the model results and observational data for research, education and policy formulation. The partnership engages in research activities aimed at developing fundamental understanding of the Sound's working, as well as addressing practical questions raised by the regional community concerning management of the Sound and its resources. The partnership will function as an estuarine research node within the NOPP Ocean Information Commons.

APPROACH

The partnership is administered from School of Oceanography, University of Washington. The lead P.I. (Kawase) will be responsible for project oversight and coordination.

Nairn and Shuman will be assisting the UW effort in coupling the Aquatic Biogeochemistry (ABC) model to the circulation model. They will be responsible for integrating King County's existing models into the NOPP data and information architecture that is designed for the partnership. Coupling of these models with the UW Puget Sound Circulation Model will begin in the second year of the partnership.

WORK COMPLETED

The overarching goal of the Partnership for FY02 was to establish working teams, bring each of the independent models to a fully functional state, and begin connecting them with each other and in-situ data. Additionally, a data management system is being designed along with a web interface for basic visualization of the both model and in-situ data.

The UW Puget Sound Circulation Model is being readied for routine one-day hindcasting of the Sound's circulation. A custom-built dual-processor computer has been purchased for the model runs. We are currently developing coupling modules with the MM5 regional weather forecasting model, and we expect the routine hindcasting to begin in early October. The model will be used as a part of a study of circulation and biological productivity in Carr Inlet in the southern Puget Sound next spring. As the first entry into the data stream system described below, two undergraduate research assistants are working this summer on plotting and calibration of all hydrographic, chemical and biological data collected during the semi-annual PRISM cruise since 1998. We intend to make this data set available for public download through the data stream this fall.

NOPP partners (UW, King Co, Ecology) have been developing a computer model to describe key biogeochemical processes in Puget Sound. The Aquatic Biogeochemical Cycling (ABC) model is spatially explicit, based on published equations for biological and chemical reactions, externally forced by hydrodynamics and sunlight, and ultimately is designed to interface with a variety of circulation models including the POM. The ABC model simulates three-dimensional concentrations of dissolved oxygen, nutrients (NO_3, PO_4, NH_4); phytoplankton biomass (three types); zooplankton biomass (three types); and dissolved and particulate organic matter (C, N, P; refractory and labile).

A one-cell version of the model has been operational from a web GUI for some time, developed under PRISM. Multi-cell operation to simulate processes in a 3-dimensional water column will be possible by interfacing the ABC model with a hydrodynamic model. A preliminary interface has been developed to couple the ABC to the POM hydrodynamic model. Initial results from the coupled bio-physical model are being compared to field data and to simulations from the Ecology EFDC model.

Another important aspect is model validation. Following consensus advice of several physical oceanographers within the Partership, Ecology designed a field study that was recently conducted to take current measurements with an ADCP (acoustic doppler current profiler) in South Puget Sound for comparison to currents predicted by the Ecology EFDC and the UW Puget Sound Circulation models. The ADCP data will also serve as groundwork for the joint fieldwork to be conducted in Carr Inlet next Spring 2003 by several members of the Partnership in support of validating models.

The Data and Information Management Team has established two focused working groups. The first group is focused on the data content, its quality, description, and application, available from the existing partners in the NOPP project. This group is following up on the results of a Partnership User Needs Survey involving twenty six respondents representing various state (40%), federal (20%) and county (13%) agencies, while the remaining respondents represented local, private and tribal interests. The second group is focused on the information management and distribution system for the shared data collection. The emphasis of this group has been on the implementation and integration of the Distributed Oceanographic Data System (DODS) and the NSF UNIDATA Internet Data Distribution (IDD) system. The two groups working together are implementing an architecture designed to communicate data between project partners as well as archive and distribute modeling results to end user. Currently the two working groups have completed the initial survey of user needs, drafted project specific metadata tags, outlined a management plan for review by project partners, placed a data server online and begun testing data source, sink and relay services using the DODS and IDD protocols.

The Partnership's Education and Visualization Team, which consists of members of the UW School of Education, UW Human Interface Technology Lab and Ocean Inquiry Project, have been meeting weekly to coordinate and work on various tasks. These fall into four broad categories: 1) moving the "Virtual Puget Sound" (VPS), a 3-D navigable learning environment based on M. Kawase's numerical model, from an SGI computer to a PC-based platform, 2) developing curricula using model output and VPS, as well as OIP's in-situ techniques, to educate students about circulation and oceanographic properties of Puget Sound, 3) developing assessment techniques that can measure learning in these environments, and 4) developing a browser-based interface for all (students and partners) to examine model and real data generated by the Partnership. A good start has been made on all of these, as well as working with other teams in the Partnership (e.g., the aquatic bio-geochemistry modeling team). Specifically, the team has: Moved the VPS software to a desktop computer; Completed an initial analysis of the content that can be used in learning activities that is both supported by data and models from NOPP partners and is compliant with State and national requirements for science education; Made progress in developing web-based tools that allow visualizations and manipulations of partners' data; Developed a prototype of a tool that assesses how students organize concepts and principles they have learned.

RESULTS

Because we are only five and half months into the project by the end of FY 2001-2002, no significant results to report at this point in time.

IMPACT/APPLICATIONS

The following will be the concrete products of this partnership:

- A suite of simulation models for the marine environment of Puget Sound, including several newly designed models, linked in a flexible hierarchy;
- A data management system for archiving and sharing model results and observational data among the partners and with the outside community;
- A delivery interface that enables a user to interact with model results and oceanographic data according to his or her purpose and level of expertise, and that can be used as a curricular resource in schools.

The outcome of our will be scientific excellence at a regional scale and a deeper understanding of the workings of Puget Sound and of estuaries in general, fjord-type estuaries in particular. This will result in, among others, scientific publications in refereed journals authored by partnership members; curricular material for K-12 science and environmental education; and help and guidance for those who need to make decisions affecting the Sound's environment.

Further, this partnership represents a new kind of collaborative effort between academia, government and a private nonprofit organization - one that capitalizes on existing strength of each and respects the different mandate that each organization carries. We believe the experience of such collaboration will itself be a valuable one and be of interest to other regions and the nation as a whole.

TRANSITIONS

No significant transitions have occurred this year since the project is still in the spin-up stage.

RELATED PROJECTS

Puget Sound Regional Synthesis Model (PRISM) is an internally funded initiative of the University to develop and consolidate University-wide expertise in natural and human environment of the Puget Sound region. The initiative is formed in response to the urgent need for environmental knowledge about the region, arising from many concerns and controversies such as protection of endangered species and old-growth forests, management of urban growth, The core of the PRISM is a suite of prognostic models that simulate the Puget Sound region's natural and human environment. These include: a mesoscale weather forecast model for the Pacific Northwest based on NCAR MM5; a distributed hydrography model of the Puget Sound watersheds based on DHSVM, the Puget Sound Circulation Model and the Aquatic Biogeochemical Systems Model (both discussed above), as well as an urban hydrology/water resource usage model (CRYSTAL) and an urban growth simulation model (UrbanSIM). PRISM has also developed a data/information management system for the region's geospatial data discussed above. It is the eventual goal of PRISM to operate all of these models in flexible coupling with one another. PRISM will act as the University's host to the Partnership; both the modeling and the data management system of PRISM will provide important leverage to the partnership's activities described here.